

## Summary of ECG

1. Take a look at the leads & determine location of each wall:

I	High lateral	aVR	V1	Septal	V4	Strictanterior	
II	Inferior	aVL	High lateral	V2	Septal	V5	Low lateral
III	Inferior	aVF	Inferior	V3	Strictanterior	V6	Low lateral
II							

2. Make spot diagnosis

3. Use the scheme to:

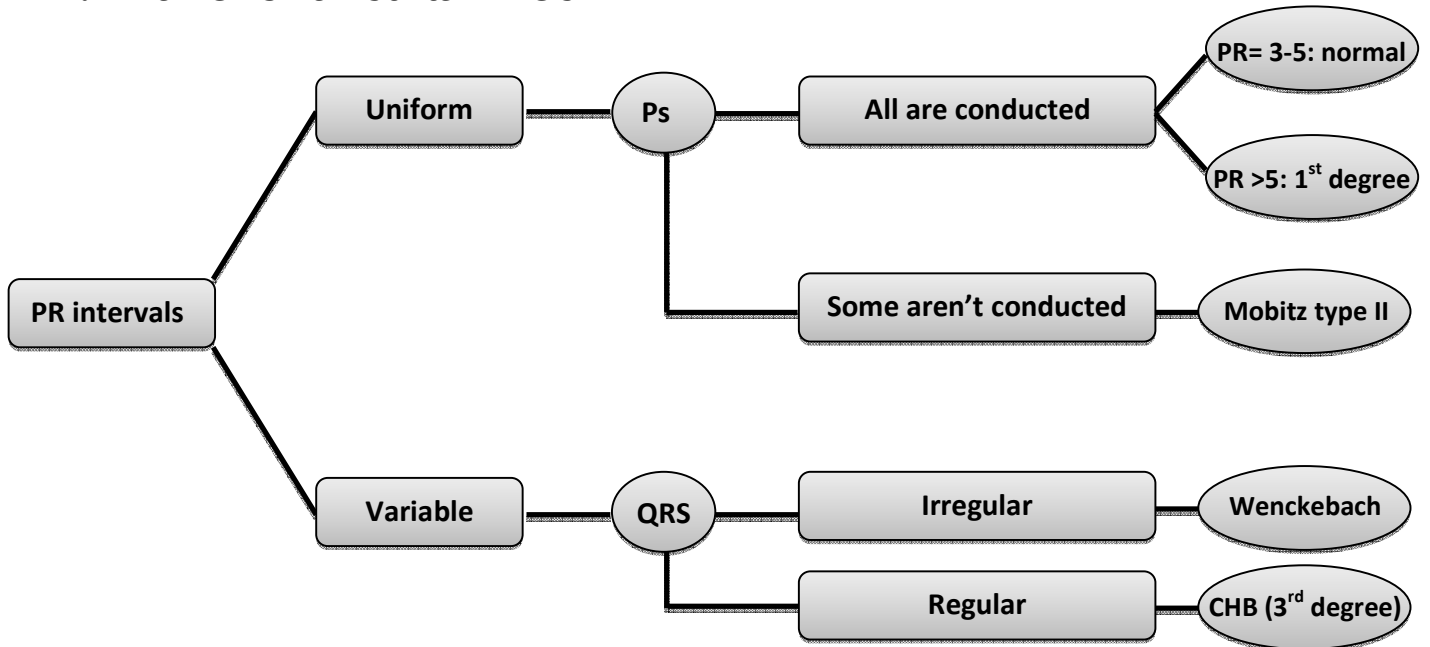
- Confirm diagnosis
- Correct diagnosis
- Complete diagnosis

### Scheme for ECG

	Abnormality	Leads to look at	
		Limb leads	Chest leads
Step I	<b>AV block</b> <b>Arrhythmia</b>	Strip or II	
Step II	<b>Atrial enlargement</b> <b>Bundle Branch Block</b> <b>Ventricular enlargement</b>	II	V1 V1, V2, V5, V6
Step III	<b>Axis</b> <b>Hemiblock</b>	I/III or aVF Limb leads	
Step IV	<b>Myocardial infarction</b> <b>Myocardial ischemia</b>		I, L → high lateral wall II, III, F → inferior wall V1, V2 → septal wall V3, V4 → strict anterior wall V5, V6 → low lateral wall
Step V	<b>Low voltage</b> <b>Digitalis</b> <b>Hyperkalemia</b> <b>Pre-excitation syndrome</b>	I, II, III In all limb leads In all limb leads In all limb leads	

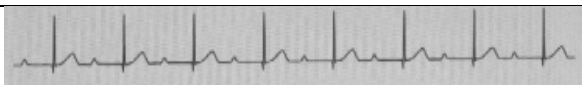
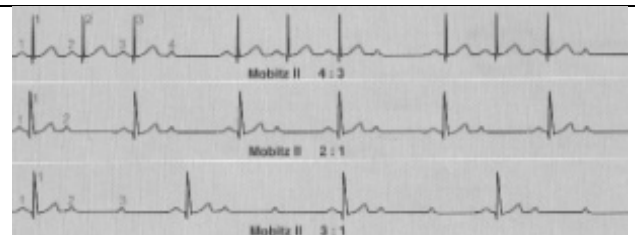
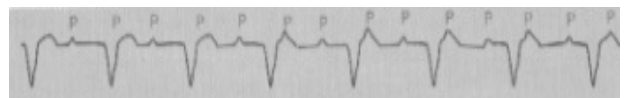
### Normally:

- **P wave**: height ≤ 2.5 small squares – width < 3 small squares.
- **PR interval (P wave + PR segment)**: width = 3-5 small squares.
- **QRS**: width < 2.5 small squares – height in LI + LII + LIII > 15 small squares.

**Step 1:****I.1 Atrioventricular Block**

In second degree only (wenckebach & Mobitz type II):

- 1- Detect degree of block (P: QRS ratio -> 6:5 or 5:4 or 4:3 etc.....).
- 2- If block is 2:1, look at the width of the QRS:
  - If wide > 2.5 = Mobitz type II.
  - If narrow = wenckebach.
- 3- If shortest PR > 5 in wenckebach or PR > 5 in Mobitz type II = 1<sup>st</sup> degree Av block is associated.

**First Degree AV Block****Mobitz Type II Second Degree AV Block****Mobitz Type I (Wenckebach) Second Degree AV Block****3rd Degree (Complete) Heart Block**

## I.2 Arrhythmia:

### 1. Regularity:

- **Regular:**

**Definition:** uniform R-R intervals +/- 1mm

**How to decide:**

- By paper or divider
- If NO strip: compare R-R intervals in different leads
- If NO R-R in leads: do NOT comment on regularity

- **Irregular:**

**Definition:** variable R-R

**Possibilities:**

- Regular irregularity
- Irregular irregularity

- **Regular with occasional irregularity:**

**Definition:** ALL R-R are regular except one i.e. premature beat

### 2. Rate: (heart rate)

- **If regular R-R interval:**

Count number of squares (big or small) in R-R interval

$$\text{Rate} = \frac{300}{\text{R-R in big squares}} \text{ OR } \frac{1500}{\text{R-R in small squares}}$$



- **If irregular R-R interval:**

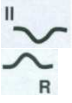


- If strip is
  - 10 big squares, so rate = number of QRS X 30
  - 20 big squares, so rate = number of QRS X 15
  - 30 big squares, so rate = number of QRS X 10
- Whether strip is present or not, choose THE MOST MIDDLE R-R INTERVAL (استوسطلك واحدة),  
 So rate =  $\frac{300}{\text{MOST MIDDLE R-R interval in big squares}}$

If NO strip & NO R-R in leads (one complex in each lead), do NOT comment

### 3. Pacemaker:

#### Scheme for pacemaker

Pacemaker	How to know		If the pacemaker is ..., so think about .....	
<b>Sinus pacemaker</b>	P wave: - Upright in II & - Inverted in aVR		<b>Normal sinus rhythm</b>	Differentiated by <b>regularity &amp; rate</b>
			<b>Sinus tachycardia</b>	
			<b>Sinus bradycardia</b>	
			<b>Sinus arrhythmia</b>	
			<b>Sinus pause</b>	
<b>Atrial pacemaker</b>	NO sinus P wave P wave according to rhythm		<b>Atrial ectopic focus</b>	Differentiated by <b>features of each pacemaker</b>
			<b>Atrial fibrillation</b>	
			<b>Atrial flutter</b>	
			<b>Multifocal atrial tachycardia</b>	
			<b>Wandering atrial tachycardia</b>	

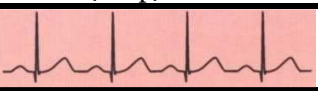

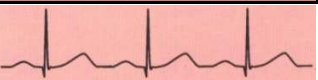
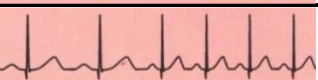
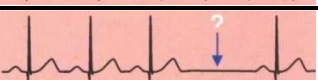
<b>Junctional pacemaker</b>	P wave: - Absent OR - Retrograde: Inverted in II, Upright in aVR Just before or just after QRS		<b>Supraventricular tachycardia</b> <b>Escape Junctional rhythm</b> <b>Accelerated Junctional rhythm</b>	Differentiated by <b>rate</b> (as ALL are regular)
<b>Ventricular pacemaker</b>	- Wide QRS Except supraheasal - T direction is opposite to QRS - +/- signs of AV dissociation		<b>Ventricular tachycardia</b> <b>Escape idioventricular rhythm</b> <b>Accelerated idioventricular rhythm</b> <b>Ventricular fibrillation</b> <b>Ventricular flutter</b>	Differentiated by <b>rate</b> (as ALL are regular except multifocal VT) <b>Spot diagnosis</b>
<b>Artificial pacemaker</b>	Spikes before QRS +/- P wave		<b>Ventricular pacemaker</b> <b>Dual pacemaker</b>	Differentiated by <b>spikes</b>

## For determining type of arrhythmia

1. Determine the pacemaker
2. Decide which type of arrhythmia according to the rate and regularity

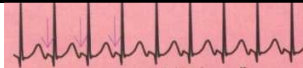
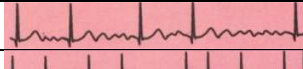
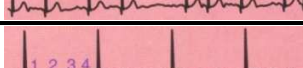
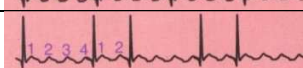
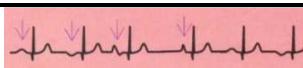
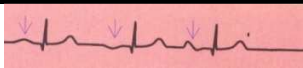
### I. Sinus pacemaker:

#### Scheme for Sinus Pacemaker

1.pacemaker	2. decide arrhythmia			
	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
<b>Sinus rhythm</b> P wave: • Upright in II • Inverted in aVR	Regular	60-100		<b>Normal sinus rhythm</b>
		100-180		<b>Sinus tachycardia</b>
		40-60		<b>Sinus bradycardia</b>
	Irregular	Any		<b>Sinus arrhythmia</b>
	Regular with OI (Dropped beat)			<b>Sinus pause (Sick Sinus Syndrome)</b>

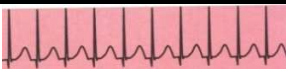

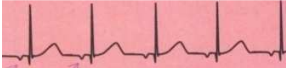
## II. Atrial pacemaker:

### Scheme for Atrial Pacemaker

1.pacemaker	2.deciding arrhythmia				Rhythm (Diagnosis)
	Pacemaker	Regularity	Rate	Lead II (Strip)	
<b>Atrial pacemaker</b> NO sinus P wave	Small P waves	Regular	>150		<b>Supraventricular tachycardia</b>
	Fibrillatory waves Absent P	Irregular	Any		<b>Coarse Atrial fibrillation</b>
	Flutter waves (Saw teeth)	Regular			<b>Atrial flutter 4:1</b>
		Irregular	Any		<b>Atrial flutter with variable block</b>
	≥ 3 different Ps	Irregular	Tachycardia		<b>Multifocal atrial tachycardia (MAT)</b>
			Bradycardia		<b>Wandering atrial pacemaker</b>

## III. Junctional pacemaker:

### Scheme for Junctional Pacemaker

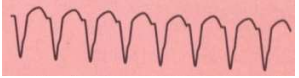
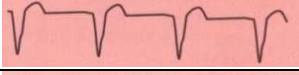
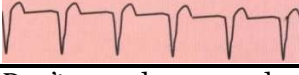
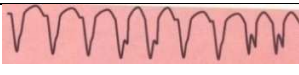
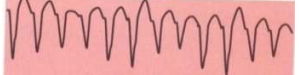
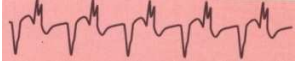


1.pacemaker	2.decide arrhythmia				Rhythm (Diagnosis)
	Regularity	Rate	Lead II (Strip)		
<b>Junctional Pacemaker</b> P absent or retrograde	Regular	>150 (>100)			<b>Supraventricular tachycardia (PAVNRT)</b>
		40-60			<b>Escape Junctional rhythm</b>
		60-100			<b>Accelerated Junctional rhythm</b>

**ALL junctional rhythms are REGULAR, unlike fine AF which is IRREGULAR**

<b>Junctional rhythm</b> (supraventricular tachycardia)	<b>Atrial Fibrillation</b>
<b>Absent P wave</b>	
Regular	Irregular





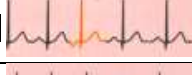

## IV. Ventricular pacemaker:

### Scheme for ventricular Pacemaker

1.pacemaker	2.decide arrhythmia				
r	Pacemaker	Regularity	Rate	Lead II (Strip)	Rhythm (Diagnosis)
<b>Ventricular pacemaker</b> Wide QRS T inversion AV dissociation			>150		<b>Ventricular tachycardia</b>
			<40		<b>Escape idioventricular rhythm</b>
			60-100		<b>Accelerated idioventricular rhythm</b>
			Don't exceed 30 seconds 3 or more beats		<b>NON sustained ventricular tachycardia</b>
		Irregular	Tachy		<b>Multifocal ventricular tachycardia</b>
					<b>Torsades de pointes</b>
					<b>Bidirectional Ventricular tachycardia</b>
<b>NO QRS</b>	<b>Vent. fibrillatory waves</b>	Irregular	Any		<b>Ventricular fibrillation</b>
	<b>Ventricular flutter waves</b>	Regular	300-400		<b>Ventricular flutter</b>

## V. Ectopic beats

### Scheme for Ectopic Beats

1. Decide whether ectopic beat is escape or premature		2. Decide whether ectopic beat (escape or premature) is atrial, junctional or ventricular		,So diagnosis					
If	,so	If							
Sinus rhythm →pause →ectopic beat →sinus rhythm	Escape beat	Small (atrial) P wave			Escape atrial beat				
		Retrograde P wave			Escape Junctional beat				
		Wide QRS T wave opposite QRS			Escape ventricular beat				
Sinus rhythm →ectopic beat →pause →sinus rhythm	Premature beat	Small (atrial) P wave	<table><tr><td>Premature</td><td>Pause</td></tr></table>	Premature	Pause		Premature atrial beat		
		Premature	Pause						
		Retrograde P wave	<table><tr><td>Less than</td><td></td></tr><tr><td>2 Normal cycles</td><td></td></tr></table>	Less than		2 Normal cycles			Premature Junctional beat
Less than									
2 Normal cycles									
Wide QRS T wave opposite QRS	<table><tr><td>Premature</td><td>Pause</td></tr><tr><td>equal</td><td></td></tr><tr><td>2 Normal cycles</td><td></td></tr></table>	Premature	Pause	equal		2 Normal cycles			Premature ventricular beat
Premature	Pause								
equal									
2 Normal cycles									

## Variable forms of premature beats:

### 1) Premature atrial beat with aberrant conduction (Ashmann phenomenon):

Premature atrial beat occurs so early that it reach the ventricles during relative refractory period. So upstroke of ventricular depolarization is slow and intraventricular conduction of the impulse is slow with subsequent wide QRS.



### 2) Premature atrial beat with non-conducted P:

Premature atrial beat occurs more early than the mentioned above, so it reaches the ventricles during absolute refractory period → no QRS



### 3) Monofocal premature beat:



#### Scheme for Monofocal Premature Beat

Monofocal premature beat	
Premature beat occurs every constant number of sinus beats	
1. Decide whether premature beats are atrial or ventricular	
If Small P wave	,So Atrial premature beats
Wide QRS T wave opposite QRS	Ventricular premature beat
Retrograde P wave	Junctional premature beats
2. Decide whether premature beats are bigeminy, trigeminy or quadrigeminy	
If (Strip)	,So Atrial bigeminy
	Atrial trigeminy
	Atrial quadrigeminy
	Ventricular bigeminy
	Ventricular trigeminy
	Ventricular quadrigeminy
	Junctional bigeminy
	Junctional trigeminy
	Junctional quadrigeminy





#### 4) Couplet:

##### Scheme for Couplet

How to know	Couplet	If	Lead II (Strip)	,So diagnosis
Sinus rhythm → premature beat		Small P wave		<b>Atrial couplet</b>
→ premature beat		Retrograde P wave		<b>Junctional couplet</b>
→ sinus rhythm		Wide QRS T wave opposite QRS		<b>Ventricular couplet</b>

#### 5) Interpolated premature beat:

##### Scheme for Interpolated Premature Beat

How to know	Interpolated premature beat	If	Lead II (Strip)	,So
Sinus rhythm → premature beat		Small P wave		<b>Interpolated PAB</b>
→ sinus beat (NO pause)		Retrograde P wave		<b>Interpolated PJB</b>
Premature cycle + return cycle = ONE normal sinus cycle		Wide QRS T wave opposite QRS		<b>Interpolated PVB</b>

## Step II

### II.1. Atrial enlargement:

Look at

		V <sub>1</sub>	
II			

##### Scheme for atrial enlargement

	II	V <sub>1</sub>
<b>Normal</b>	Positive, W < 3mm, H ≤ 2.5mm	Biphasic
<b>Left</b>	Broad, W ≥ 3mm P mitral +/- notched	-ve > 1x1
<b>Right</b>	Tall and peaked, H > 2.5 P pulmonale	+ve > 1.5 in H
<b>Biatrial</b>	P mitral & P pulmonale	+ve P is tall > 1.5 & -ve P is board > 1

**For diagnosis of atrial enlargement, a change in ONE lead is ENOUGH**



## II.2. Bundle Branch Block:

Look at

		V1	
		V2	V5
			V6

**Spot diagnosis: WIDE QRS at V1, V2, V5, V6**

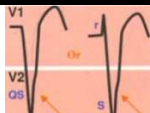
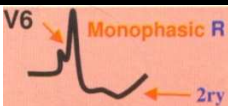
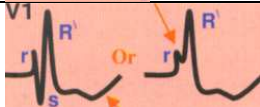

i. Is QRS complex (Normal < 2.5mm) wide?

If >3mm → complete BBB

If 2.5-3mm → incomplete BBB

ii. In both cases, determine whether right or left:

### Scheme for Bundle Branch Block

	V1, V2		V5, V6 & I		
<b>LBBB</b>	QS or rS		+	Monophasic R with secondary inversion of T wave	
<b>RBBB</b>	rSR' or monophasic R with secondary inversion of T wave		+	qRs (with slurred s)	
<b>IVCD</b>	LBBB		+	RBBB	
	RBBB		+	LBBB	

➤ If RBBB is diagnosed, NEVER diagnose:

- Ventricular enlargement
- Myocardial ischemia

➤ If LBBB is diagnosed, NEVER diagnose : above conditions+

- Myocardial infarction (diagnosed if new onset LBBB with typical ischemic chest pain or elevated cardiac enzymes)
- Hemiblock.

➤ **Pacemaker: in LBBB ONLY (or IVCD)**

If LBBB is associated with spikes, this indicates pacemaker:

- If one spike (before QRS) → ventricular pacemaker
- If TWO spikes (one before P, and other before QRS) → Dual pacemaker
- If spike is NOT followed by QRS → malfunctioning pacemaker

## II.3. Ventricular enlargement:

Look at

		V1	
		V2	V5
			V6

### Scheme for Ventricular Enlargement

**V1, V2**

**V5, V6**

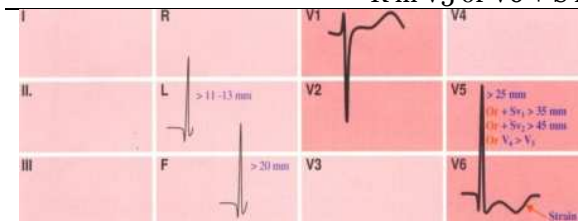
**LVE** 6 features (ANY one is diagnostic, but ALL must be excluded negative to exclude LVE)

R in V5 or V6 > **25 mm** (5 big squares)

R in V5 or V6 + S in V1 > **35 mm** (7 big squares)

R in V5 or V6 + S in V2 > **45 mm** (9 big squares)

R in V6 > R in V5



R in aVL > **13 mm**

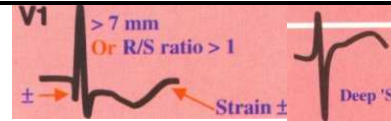
R in aVF > **20 mm**

+/- ST depression (strain sign) = hypertrophy > dilatation

**RVE** Tall R in V1 > 7 mm or R in V1 ≥ S in V1

Deep S in V6

+/- ST depression (strain sign) = hypertrophy > dilatation



**BVE** Signs of LVE + tall R in V1 or Signs of LVE + Rt. Axis deviation.

## Step III

### III.1. Axis:

Look at:

I			
III	aVF		

### Scheme for Axis

	Normal axis deviation	Left axis deviation	Right axis deviation	Extreme axis deviation
I				
III or aVF				

IF THE AXIS IS DEVIATED, SEARCH FOR HEMIBLOCK


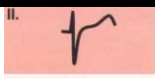


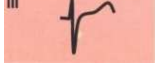







### III.2. Hemiblock:

Look at: inferior and high lateral leads

I			
II	aVL		
III	aVF		

Search for hemiblock if axis is deviated

#### Scheme for Hemiblock

<b>LAHB</b>	Left axis deviation		Deep S in inferior leads (II, III, aVF) in aVF especially (as normal in III)		
Left anterior HB			(NO need to exclude other causes of left axis deviation)		
		III			
<b>LPHB</b>	Right axis deviation		Deep S in high lateral leads (I, aVL) (provided that it is NOT explained by RVE)		
Left posterior HB					
		F			

**NB** | If hemiblock + RBBB → **Bifascicular block** hemiblock  
 If hemiblock + RBBB + 1<sup>st</sup> HB → **Trifascicular block** hemiblock

## Step IV

### IV.1.2. Myocardial infarction and ischemia:

Search for ALL changes in EACH lead

Changes:

- Is there Pathological Q (or poor progression of R)?
  - Is there ST elevation (or ST depression)?
  - Is there T inversion (or hyperacute, biphasic or flat T wave)?
- CHANGES must be in 2 SUCCESSIVE LEADS of the SAME WALL**

➤ **Pathological Q:**

- Wide ( $\geq 1\text{mm}$ ) & deep ( $\geq 2\text{mm}$  or  $\geq 1/4$  the following R)
- In 2 successive lead of the same wall

➤ **Poor progression of R: in anterolateral infarction**

- R is NOT  $>S$  in V<sub>4</sub>

➤ **ST elevation:**

- First mm after J point is elevated than isoelectric line
- Isoelectric lines (baseline) are P-R segment or T-P segment
- Considered elevated if:
  - $\geq 1\text{mm}$  in limb leads
  - $\geq 2\text{mm}$  in chest leads

- Determine straightened or coved according to T wave & J point elevation
- **These changes MUST be IN 2 SUCCESSIVE LEADS of the SAME WALL**

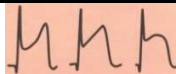
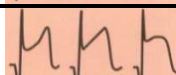

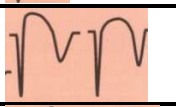
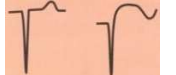
**If:**

- ST elevation (+/- ST depression in other walls) → **ST elevation Myocardial Infarction (+/- reciprocal ST depression)**
- ST depression ONLY → **Myocardial ischemia**

**If ST Elevation Myocardial Infarction, determine age & site:**

### 1. Age:

#### Scheme for age of STEMI

Spot diagnosis	Age of STEMI	How to know			
		ST segment	Q wave	T wave	
	<b>Hyperacute</b>	ST elevation	NO pathological Q	+/- Hyperacute T wave	
	<b>Acute</b>	ST elevation	Pathological Q Or poor R progression	+/- Hyperacute T wave	
				Biphasic (intermediate phase)	
	<b>Evolving</b>	ST elevation	Pathological Q Or poor R progression	Inverted T	
	<b>Old</b>	NO ST elevation	Pathological Q Or poor R progression	Normal T	

### 2. Site:

<b>I</b>	High lateral	aVR	V1	Septal	V4	Strict anterior
<b>II</b>	Inferior	aVL	V2	Septal	V5	Low lateral
<b>III</b>	Inferior	aVF	V3	Strict anterior	V6	Low lateral

**Anteroseptal**= V1-V3 +\/- V4

**Anterolateral**=V3-V6+I&aVL

**Extensive anterior**=  
V3-V6+I&aVL

Posterior wall MI:

- Tall R in V1, V2, V3 – ST depression – upright T
- Associated with inferior myocardial infarction (to differentiate it from RVE)

**RVE**

**Posterior MI**

Tall R in V1, V2, V3

**Associated with Inferior MI**

**ST depression in some leads:**

- If associated with ST elevation in other leads → **RECIPROCAL ST DEPRESSION** associated with MI



- If alone → **MYOCARDIAL ISCHEMIA:**

**ST depression:** start after J point, is  $\geq 1\text{mm}$  in limb leads or  $\geq 2\text{mm}$  in chest leads & last for  $> 2\text{mm}$ .

**T wave:** flat or symmetrically inverted or symmetrically upright.

**Step V****V.1. Low voltage:**

Look at

I			
II			
III			

How to know

- QRS in I + II + III  $< 15\text{mm}$

NB

**Electrical alternans in pericardial effusion:**

- LOW voltage

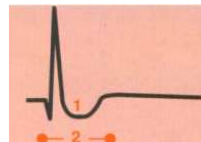
+

**V.2. Digitalis effect: in ALL LEADS**

Digitalis effect:

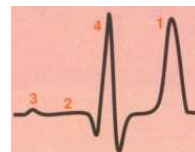
- Short QT i.e.  $QT < \frac{1}{2} RR$
- Sagging ST depression:
  - J point is isoelectric (unlike ischemia)
  - ST depression + T inversion
  - Fused ST & T

NB | Normal  $QT = \frac{1}{2} RR$

**V.3. Hyperkalemia: in ALL LEADS**

How to know:

**Hyperacute T wave alone** (tall, narrow & peaked)

**V.4. Preexcitation syndrome: in ALL LEADS****Scheme for preexcitation syndromes****WPW-Wolf Parkinson White**

- Short PR interval
- Delta wave
- Wide QRS

**LGL-Lawn Ganong Levine**

- Short PR interval

